

21.30 MATERIAL

MATERIAL associates physical parameters with materials in the mesh. The parameter default values for standard semiconductors are shown in [Appendix B “Material Systems”](#).

Syntax

```
MATERIAL <localization> <material_definition>
```

Parameter	Type	Default	Units
A.DEFPOT	Real	2.1	eV
A.LANGEVIN	Real	1.0	
A.2D.LANGEVIN	Real	0.75	
A.PASSLER	Real	3.18×10^{-4}	eV/K
A.SINGLET	Real	1.8	nm
A.TRAPCOULOMBIC	Real	1.0	
A1.RAJ	Real	3.231×10^2	cm ⁻¹
A2.RAJ	Real	7.237×10^3	cm ⁻¹
AD.RAJ	Real	1.056×10^6	cm ⁻¹
A1	Real	0.0	
A2	Real	0.0	
A3	Real	0.0	
A4	Real	0.0	
A5	Real	0.0	
A6	Real	0.0	
AADACHI	Real	see Appendix B	
ABSORPTION.SAT	Real	1.0×10^7	
AC	Real	0.0	eV
AFFINITY	Real	see Appendix B	eV
ALATTICE	Real	0.0	A
ALIGN	Real	use AFFINITY	
ALPHA.2D.LANGEVIN	Real	0.037	
ALPHAA	Real	0.0	

Parameter	Type	Default	Units
ALPHAR	Real	4.0	
AN	Real	1.0	
AN2	Real	7.03×10^5	cm^{-1}
AN0.VALD	Real	4.3383	
AN1.VALD	Real	-2.42×10^{-12}	
AN2.VALD	Real	4.1233	
AP0.VALD	Real	2.376	
AP1.VALD	Real	0.01033	
AP2.VALD	Real	1.0	
AP	Real	1.0	
AP2	Real	1.682×10^6	cm^{-1}
ARICHN	Real	see Appendix B	$\text{A}/\text{cm}^2/\text{K}^2$
ARICHP	Real	see Appendix B	$\text{A}/\text{cm}^2/\text{K}^2$
ASTR	Real	0.0	
ASYMMETRY	Real	0.5	
A.TC.A	Real	0.0	$\text{cm K}/\text{W}$
A.TC.B	Real	0.0	cm/W
A.TC.C	Real	0.0	$\text{cm}/\text{W}/\text{K}$
A.TC.CONST	Real	0.0	($\text{W}/\text{cm}/\text{K}$)
A.TC.D	Real	0.0	K
A.TC.E	Real	0.0	W/cm
A.TC.NPOW	Real	0.0	-
AUG.CNL	Real	2.2×10^{-31}	cm^6/s
AUG.CPL	Real	9.2×10^{-32}	cm^6/s
AUG.CHI	Real	1.66×10^{-80}	cm^6/s
AUGN	Real	see Appendix B	cm^6/s
AUGP	Real	see Appendix B	cm^6/s
AUGKN	Num	0.0	cm^3

Parameter	Type	Default	Units
AUGKP	Num	0.0	cm ³
AV	Real	0.0	eV
B.TRAPCOULOMBIC	Real	1.0	
B.DEFPOT	Real	-2.33	eV
BADACHI	Real	see Appendix B	
BBB	Real	0.0	eV
BB.A	Real	4.0×10^{14}	eV ² *s ⁻¹ *cm ⁻¹
BB.B	Real	1.97×10^7	V/cm
BB.GAMMA	Real	2.5	
BBT.ALPHA	Real	0	
BETAN	Real	1.0	
BETAP	Real	1.0	
BETA.RAJ	Real	7.021×10^4	eV/K
BGN.C	Real	0.5	
BGN.E	Real	9.0×10^{-3} (Slotboom) 6.92×10^{-3} (Klaassen) 6.84×10^{-3} (Bennett) 1.87×10^{-2} (del Alamo)	eV
BGN.N	Real	1.0×10^{17} (Slotboom) 1.3×10^{17} (Klaassen) 3.162×10^{18} (Bennett) 7.0×10^{17} (del Alamo)	cm ⁻³
BN	Real	1.0	
BN2	Real	1.231×10^6	V/cm
BN1.VALD	Real	0.0	

Parameter	Type	Default	Units
BN0.VALD	Real	0.235	
BP	Real	1.0	
BP2	Real	2.036×10^6	V/cm
BP0.VALD	Real	0.17714	
BP1.VALD	Real	-0.002178	
BQP.NGAMMA	Real	1.2	
BQP.NALPHA	Real	0.5	
BQP.PGAMMA	Real	1.0	
BQP.PALPHA	Real	0.5	
BSTR	Real	0.0	
C.DEFPOT	Real	-4.75	eV
C.DIRECT	Real	0.0	cm ³ /s
C1.RAJ	Real	5.5	
C2.RAJ	Real	4.0	
C11	Real	0.0	GPa
C12	Real	0.0	GPa
C13	Real	0.0	GPa
C33	Real	0.0	GPa
CDL.COUPLING	Real	1.0	s ⁻¹ cm ⁻³
CDL.ETR1	Real	0.0	eV
CDL.ETR2	Real	0.0	eV
CDL.TN1	Real	1.0	s
CDL.TN2	Real	1.0	s
CDL.TP1	Real	1.0	s
CDL.TP2	Real	1.0	s
CHI.EG.TDEP	Real	0.5	
CON.BGN	Real	0.5	
CN	Real	0.0	
CN2	Real	0.0	cm ⁻¹ K ⁻¹

Parameter	Type	Default	Units
CN0.VALD	Real	1.6831×10^4	
CN1.VALD	Real	4.3796	
CN2.VALD	Real	1.0	
CN3.VALD	Real	0.13005	
COPT	Real	0.0	cm ³ /s
CP	Real	0.0	
CP2	Real	0.0	cm ⁻¹ K ⁻¹
CP0.VALD	Real	0.0	
CP1.VALD	Real	0.00947	
CP2.VALD	Real	2.4929	
CP3.VALD	Real	0.0	
CSTR	Real	0.0	
D.DEFPOT	Real	1.1	eV
D.TUNNEL	Real	10^{-6}	cm
D0.H1	Real	1.75×10^{-4}	cm ² s ⁻¹
D0.H2	Real	1.75×10^{-4}	cm ² s ⁻¹
D1	Real	0.0	eV
D2	Real	0.0	eV
D3	Real	0.0	eV
D4	Real	0.0	eV
DADACHI	Real	see Appendix B	eV
DEC.DEG	Real	see Table 5-13	
DEC.C1	Real	0.0	eV
DEC.C2	Real	0.0	eV
DEC.C3	Real	0.0	eV
DEC.ISO	Real	0.0	eV
DEC.D2	Real	0.0	eV
DEC.D4	Real	0.0	eV

Parameter	Type	Default	Units
DEV.HH	Real	0.0	eV
DEV.LH	Real	0.0	eV
DEV.ISO	Real	0.0	eV
DEV.SO	Real	0.0	eV
DEGENERACY	Integer	2	
DELTA1	Real	0.0	eV
DELTA2	Real	0.0	eV
DELTA3	Real	0.0	eV
DEVICE	Character		
DGN.GAMMA	Real	3.6	
DGP.GAMMA	Real	3.6	
DINDEXDT	Real	0.0	1/K
DIST.SBT	Real	10^{-6}	cm
DKCQ.EXCITON	Real	1.1×10^{-8}	s ⁻¹
DKNRS.EXCITON	Real	0	s ⁻¹
DKSS.EXCITON	Real	3×10^{-8}	cm ³ s ⁻¹
DN2	Real	0.0	cm ⁻¹ K ⁻¹
DN0.VALD	Real	1.233735×10^6	
DN1.VALD	Real	1.2039×10^3	
DN2.VALD	Real	0.56703	
DOPE.SPECT	Character		
DP2	Real	0.0	cm ⁻¹ K ⁻¹
DP0.VALD	Real	1.4043×10^6	
DP1.VALD	Real	2.9744×10^3	
DP2.VALD	Real	1.4829	
DPHEFF.EXCITON	Real	1	
DRST.EXCITON	Real	0.25	
DTAUS.EXCITON	Real	5×10^{-9}	s

Parameter	Type	Default	Units
DRHODT	Real	0.0	$\mu\Omega \cdot \text{cm}/\text{k}$
DSTR	Real	0.0	
E.CONDUC	Real	0.0	Ω/cm
E.FULL.ANISO	Logical	False	E.FULL.ANISO
E31	Real	0.0	cm^{-2}
E33	Real	0.0	cm^{-2}
EA.H1	Real	0.1685	cm^2s^{-1}
EA.H2	Real	0.1685	cm^2s^{-1}
EAB	Real	0.045	eV
ECN.II	Real	1.231×10^6	
ECP.II	Real	2.036×10^6	
EDB	Real	0.044	eV
EG1.RAJ	Real	1.1557	eV
EG2.RAJ	Real	2.5	eV
EG3.RAJ	Real	3.2	eV
EG300	Real	see Appendix B	eV
EG1300	Real	0.0	eV
EG2300	Real	0.0	eV
EG12BOW	Real	0.0	eV
EG1ALPH	Real	0.0	eV/K
EG2ALPH	Real	0.0	eV/K
EG1BETA	Real	0.0	K
EG2BETA	Real	0.0	K
EGALPHA	Real	see Appendix B	eV/K
EGBETA	Real	see Appendix B	K
EMISS.EFFI	Real	1.0	
EMISS.LAMB	Real	0.5	microns
EMISS.NX	Integer	1	

Parameter	Type	Default	Units
EMISS.NY	Integer	1	
EMISS.WIDE	Real	1.0	microns
EMISSION.FACTOR	Real	27.1728×10^{-5}	
EN	Real	0.0	
EP	Real	0.0	
EP.MBULK	Real	see Table 3-132	eV
EP1.RAJ	Real	1.827×10^{-2}	eV
EP2.RAJ	Real	5.773×10^{-2}	eV
EPS11	Real	0.0	
EPS12	Real	0.0	
EPS13	Real	0.0	
EPS22	Real	0.0	
EPS23	Real	0.0	
EPS33	Real	0.0	
EPS.XX	Real	0.0	
EPS.YY	Real	0.0	
EPS.ZZ	Real	0.0	
ESTR	Real	0.0	
ETRAP	Real	0.0	eV
EPSINF	Real		
EXN.II	Real	1.0	
EXP.II	Real	1.0	
F.ALPHAA	Character		
F.BANDCOMP	Character		
F.BBT	Character		
F.BGN	Character		
F.CBDOSFN	Character		
F.COMMUN	Character		
F.COMMUP	Character		

Parameter	Type	Default	Units
F.COFT	Character		
F.EPSILON	Character		
F.ENMUN	Character		
F.ENMUP	Character		
F.PDN	Character		
F.PDP	Character		
F.FERRO	Character		
F.GAUN	Character		
F.GAUP	Character		
F.INDEX	Character		
F.MAX	Real	0.0	V/cm
F.MIN	Real	0.0	V/cm
F.MNSNDIFF	Character		
F.MNSPDIFF	Character		
F.MNSNFLICKER	Character		
F.MNSPFLICKER	Character		
F.MUNSAT	Character		
F.MUPSAT	Character		
F.NUMBER	Integer	0	
F.RECOMB	Character		
F.TAUN	Character		
F.TAUP	Character		
F.TAURN	Character		
F.TAURP	Character		
F.TCAP	Character		
F.TCOND	Character		
F.VBDOSFN	Character		
F.VSATN	Character		
F.VSATP	Character		

Parameter	Type	Default	Units
FB.MBULK	Real	see Table 3-132	
FC.RN	Real	3.0×10^{-18}	cm ⁻²
FC.RP	Real	7.0×10^{-18}	cm ⁻²
FERRO.EC	Real	0.0	V/cm
FERRO.EPSF	Real	1.0	
FERRO.PS	Real	0.0	C/cm ²
FERRO.PR	Real	0.0	C/cm ²
FSTR	Real	0.0	
G.2D.LANGEVIN	Real	1	
GAIN.SAT	Real	1.0×10^7	
GAIN0	Real	2000.0	cm ⁻¹
GAIN00	Real	-200.0	cm ⁻¹
GAIN1N	Real	0	cm ²
GAIN1P	Real	0	cm ²
GAIN1MIN	Real	3.0×10^{-16}	cm ²
GAIN2NP	Real	0	cm ⁵
GAMMA	Real		
GAMMA.RAJ	Real	1108.0	K
GCB	Real	2.0	
GN1	Real	3.0×10^{-16}	cm ⁻²
GN2	Real	4.0×10^{-15}	cm ⁻²
G.SURF	Real	1.0	cm ²
GVB	Real	4.0	
H1TOH2RATE	Real	1.0E-2	cm ⁻³ s ⁻¹
H2TOH1RATE	Real	100.0	s ⁻¹
H1SRV	Real	0.0	cm/s
H2SRV	Real	0.0	cm/s

Parameter	Type	Default	Units
HC.A	Real	See Appendix B	J/Kcm ³
HC.B	Real	See Appendix B	J/K ² cm ³
HC.BETA	Real		
HC.C	Real	See Appendix B	J/K ³ cm ³
HC.C1	Real		J/K/kg
HC.C300	Real		J/K/kg
HC.D	Real	See Appendix B	JK/cm ³
HC.RHO	Real		g/cm ³
HOOGEN	Real	0.0	
HNS.AE	Real	6.7×10 ⁻³²	cm ⁶ /s
HNS.AH	Real	7.2×10 ⁻³²	cm ⁶ /s
HNS.BE	Real	2.45×10 ⁻³¹	cm ⁶ /s
HNS.BH	Real	4.5×10 ⁻³³	cm ⁶ /s
HNS.CE	Real	-2.2×10 ⁻³²	cm ⁶ /s
HNS.CH	Real	2.63×10 ⁻³²	cm ⁶ /s
HNS.HE	Real	3.4667	
HNS.HH	Real	8.25688	
HNS.NOE	Real	1.0×10 ¹⁸	cm ⁻³
HNS.NOH	Real	1.0×10 ¹⁸	cm ⁻³
HNU1	Real	1.0	eV
HNU2	Real	1.0	eV
HOGEP	Real	0.0	
HOPN.BETA	Real	1.5	
HOPN.GAMMA	Real	5×10 ⁻⁷	cm ⁻¹
HOPN.V0	Real	1×10 ¹¹	Hz
HOPP.BETA	Real	1.5	
HOPP.GAMMA	Real	1×10 ¹¹	cm ⁻¹

Parameter	Type	Default	Units
HOPP.V0	Real	1×10^{11}	Hz
HUANG.RHYS	Real	3.5	
IF.CHAR	Real	0.0	microns
IG.ELINR	Real	6.16×10^{-6}	cm
IG.HLINR	Real	6.16×10^{-6}	cm
IG.ELINF	Real	9.2×10^{-7}	cm
IG.HLINF	Real	9.2×10^{-7}	cm
IINOFF	Character		
IIPOFF	Character		
IMAG.INDEX	Real	See Appendix B	
INDEX.FILE	Character		
INDX.IMAG	Character		
INDX.REAL	Character		
INSULATOR	Logical	False	
J.ELECT	Real	0.0	A/cm ²
J.MAGNET	Real	0.0	V/cm ²
JTAT.M2	Real	10^{-20}	V ² cm ³
K.SHIFT	Real	0.0	eV
K.SINGLET	Real		
KAUGCN	Real	1.83×10^{-31}	cm ⁶ /s
KAUGCP	Real	2.78×10^{-31}	cm ⁶ /s
KAUGDN	Real	1.18	
KAUGDP	Real	0.72	
KD.LID	Real	5×10^{-15}	cm ³ s ⁻¹
KH.LID	Real	5×10^{-18}	cm ³ s ⁻¹
KISC.EXCITON	Real	0	s ⁻¹
KNRS.EXCITON	Real	0	s ⁻¹

Parameter	Type	Default	Units
KNRT . EXCITON	Real	0	s ⁻¹
KSP . EXCITON	Real	0	cm ⁻³ s ⁻¹
KSRHCN	Real	3.0×10 ⁻¹³	cm ³
KSRHCP	Real	11.76×10 ⁻¹³	cm ³
KSRHGN	Real	1.77	
KSRHGP	Real	0.57	
KSRHTN	Real	2.5×10 ⁻³	s
KSRHTP	Real	2.5×10 ⁻³	s
KSS . EXCITON	Real	0	cm ⁻³ s ⁻¹
KST . EXCITON	Real	0	cm ⁻³ s ⁻¹
KTP . EXCITON	Real	0	cm ⁻³ s ⁻¹
KTT . EXCITON	Real	0	cm ⁻³ s ⁻¹
L . 2D . LANGEVIN	Real	1.6	nm
L1SELL	Real	Appendix B	μm
L2SELL	Real	Appendix B	μm
LAM1	Real	0	μm
LAM2	Real	0	μm
LAMDAE	Real	6.2×10 ⁻⁷	cm
LAMDAH	Real	3.8×10 ⁻⁷	cm
LAMHN	Real	9.2×10 ⁻⁷	cm
LAMHP	Real	9.2×10 ⁻⁷	cm
LAMRN	Real	6.16×10 ⁻⁶	cm
LAMRP	Real	6.16×10 ⁻⁶	cm
LAN300	Real	6.2×10 ⁻⁷	cm
LAP300	Real	3.8×10 ⁻⁷	cm
LDS . EXCITON	Real	0.01	μm
LDT . EXCITON	Real	0.632	μm

Parameter	Type	Default	Units
LT.TAUN	Real	0.0	
LT.TAUP	Real	0.0	
LUTT1	Real	0.0	
LUTT2	Real	0.0	
LUTT3	Real	0.0	
M.DSN	Real	See Appendix B	
M.DSP	Real	See Appendix B	
M.VTHN	Real		
M.VTHP	Real		
MATERIAL	Character		
MAG.LOSS	Real	0.0	mho/cm
MBULKSQ	Real		eV
MC	Real	0.0	
ME.TUNNEL	Real		
MH.TUNNEL	Real		
ME.SBT	Real		
MH.SBT	Real		
MHH	Real	0.49	
MINIMA	Real	6	
ML	Real	0.916	
MLH	Real	0.16	
MSO	Real	0.23	
MSTAR	Real	0.0	
MTT	Real	0.0	
MT1	Real	0.191	
MT2	Real	0.191	
MUN	Real	See Appendix B	
MUNOFF	Character		
MUPOFF	Character		

Parameter	Type	Default	Units
MUP	Real	See Appendix B	
MV	Real	0.0	
MZZ	Real	0.0	
N.ANISO	Logical	False	
N.ALPHA	Real	0.0	degrees
N.BETA	Real	0.0	degrees
N.GAMMA	Real	0.0	degrees
N.ION.1	Real	0.0	cm ⁻¹ K ⁻¹
N.ION.2	Real	0.0	cm ⁻¹ K ⁻²
N.IONIZA	Real	7.03×10 ⁵	cm ⁻¹
N.SHIFT	Real	0.0	eV
N.XX	Real	1.0	
N.YY	Real	1.0	
N.ZZ	Real	1.0	
NK.SHIFT	Real	0.0	eV
N0.BGN	Real	1.0×10 ¹⁷	cm ⁻³
NAME	Character		
NC.F	Real	1.5	
NC300	Real	See Appendix B	cm ⁻³
NDX.ADACHI	Logical	False	
NDX.SELLMEIER	Logical	False	
NHNU	Integer	0	
NI.MIN	Real	0.0	cm ⁻³
NK.EV	Logical	False	
NK.NM	Logical	False	
NLAM	Integer	0	
N.SCH.GAMMA	Real	1.0	s
N.SCH.MAX	Real	3.0×10 ⁻⁶	s

Parameter	Type	Default	Units
N.SCH.MIN	Real	0.0	s
N.SCH.NREF	Real	1.0×10^{16}	cm ⁻³
NSRHN	Real	See Appendix B	cm ⁻³
NSRHP	Real	See Appendix B	cm ⁻³
NTRANSPARENT	Real	2.0×10^{18}	cm ⁻³
NUE.EXTR	Real		
NUH.EXTR	Real		
NV.F	Real	1.5	
NV300	Real	See Appendix B	cm ⁻³
OP.PH.EN	Real	0.063	eV
OPPHE	Real	0.063	eV
OUT.DSPEC	Character		
OUT.INDEX	Character		
OUT.USPEC	Character		
OXCH.ONLY	Logical	False	
P.ION.1	Real	0.0	cm ⁻¹ K ⁻¹
P.ION.2	Real	0.0	cm ⁻¹ K ⁻¹
P.IONIZA	Real	1.682×10^6	cm ⁻¹
P.PASSLER	Real	2.33	
P.SCH.GAMMA	Real	1.0	s
P.SCH.MAX	Real	3.0×10^{-6}	s
P.SCH.MIN	Real	0.0	s
P.SCH.NREF	Real	1.0×10^{16}	cm ⁻³
PCM.AEA	Real	3.2	eV
PCM.AP	Real	1.0	
PCM.ARHO	Real		$\mu\Omega\text{cm}$
PCM.ATAU	Real		S
PCM.ATC	Real		K

Parameter	Type	Default	Units
PCM.CEA	Real	3.7	eV
PCM.CP	Real	1.0	
PCM.CRHO	Real		$\mu\Omega\text{cm}$
PCM.CTAU	Real		S
PCM.CTC	Real		K
PCM.LATHEAT	Real	0.0	J
PDA.N	Real	0.2	
PDA.P	Real	0.2	
PDEXP.N	Real	-2.5	
PDEXP.P	Real	-2.5	
PERM.ANISO	Real	-999.0	
PERMEABILITY	Real	1.0	
PERMITTIVITY	Real	See Appendix B	
PHEFF.EXCITON	Real	1	
PHONON.ENERGY	Real	0.068	eV
PIP.ACC	Real	2.0	
PIP.ET	Real	1.0	eV
PIP.NT	Real	0.0	cm^2
PIP.OMEGA	Real	0.07	eV
POWER	Real		
PSP	Real	0.0	cm^{-2}
QE.EXCITON	Real	0.0	
QR.EXCITON	Real	0.0	
REAL.INDEX	Real	See Appendix B	
REGION		All regions	
RESISTIVITY	Real		$\mu\Omega\cdot\text{cm}$
RST.EXCITON	Real	0.25	
RST.TT.EXCITON	Real	RST.EXCITON	
S.BINDING	Real	0.1	eV

Parameter	Type	Default	Units
S0SELL	Real	See Appendix B	
S1SELL	Real	See Appendix B	
S2SELL	Real	See Appendix B	
SIG.LID	Real	1.0×10^{-8}	$\text{cm}^{-3}\text{s}^{-1}$
SEMICONDUC	Logical	False	
SO.DELTA	Real	see Table 3-132	eV
SOPRA	Character		
SPECIES1.AF	Real	1.0e15	Hz
SPECIES1.EA	Real	0.25	eV
SPECIES1.HOP	Real	1.0×10^{-6}	cm
SPECIES2.AF	Real	1.0e15	Hz
SPECIES2.EA	Real	0.25	eV
SPECIES2.HOP	Real	1.0×10^{-6}	cm
SPECIES3.AF	Real	1.0e15	Hz
SPECIES3.EA	Real	0.25	eV
SPECIES3.HOP	Real	1.0×10^{-6}	cm
STABLE	Integer		
STRUCTURE	Character		
T.PASSLER	Real	406.0	
TAA.CN	Real	1.0×10^{-12}	cm^3/s
TAA.CP	Real	1.0×10^{-12}	cm^3/s
TANI.CONST	Logical	False	
TANI.POWER	Logical	False	
TANI.POLYNOM	Logical	False	
TANI.RECIP	Logical	false	
TAUMOB.EL	Real	0.4×10^{-12}	s
TAUMOB.HO	Real	0.4×10^{-12}	s
TAUN0	Real	See Appendix B	s
TAUP0	Real	See Appendix B	s

Parameter	Type	Default	Units
TAUREL.EL	Real	0.4×10^{-12}	s
TAUREL.HO	Real	0.4×10^{-12}	s
TAUS.EXCITON	Real	1×10^{-9}	s
TAUT.EXCITON	Real	1×10^{-9}	s
TC.A	Real	See Appendix B	$\frac{cm \cdot K}{W}$
TC.B	Real	See Appendix B	$\frac{cm}{W}$
TC.C	Real	See Appendix B	$\frac{cm}{W \cdot K}$
TC.CONST	Real		W/cm·K
TC.NPOW	Real		
TC.D	Real		K
TC.E	Real		W/cm
TC.FULL.ANISO	Logical	False	
TCOEFF.N	Real	2.55	
TCOEFF.P	Real	2.55	
TCON.CONST	Logical		
TCON.POWER	Logical		
TCON.POLYNOM	Logical		
TCON.RECIPRO	Logical		
TE.MODES	Logical	False	
TLU.A	Real	0	eV
TLU.C	Real	0	eV
TLU.E0	Real	0	eV
TLU.EC	Real	0	eV
TLU.EG	Real	0	eV
TLU.EPS	Real	1.0	
TMUN	Real		
TMUP	Real		

Parameter	Type	Default	Units
TRE.T1	Real		s
TRE.T2	Real		s
TRE.T3	Real		s
TRE.W1	Real		eV
TRE.W2	Real		eV
TRE.W3	Real		eV
TRH.T1	Real		s
TRH.T2	Real		s
TRH.T3	Real		s
TRH.W1	Real		eV
TRH.W2	Real		eV
TRH.W3	Real		eV
U.DEFPOT	Real	10.5	eV
UBGN.B	Real	3.1×10^{12}	
UBGN.C	Real	-3.9×10^{-5}	
USER.DEFAULT	Character		
USER.GROUP	Character	SEMICONDUCTOR	
USER.SPECT	Character		
V0.BGN	Real	9.0×10^{-3}	eV
VAL.AN0	Real	4.3383	
VAL.AN1	Real	-2.42×10^{-12}	
VAL.AN2	Real	4.1233	
VAL.AP0	Real	2.376	
VAL.AP1	Real	0.01033	
VAL.AP2	Real	1.0	
VAL.BN0	Real	0.235	
VAL.BN1	Real	0.0	
VAL.CN0	Real	1.6831×10^4	

Parameter	Type	Default	Units
VAL.CN1	Real	4.3796	
VAL.CN2	Real	1.0	
VAL.CN3	Real	0.13005	
VAL.DN0	Real	1.233735×10^6	
VAL.DN1	Real	1.2039e3	
VAL.DN2	Real	0.56703	
VAL.BP0	Real	0.17714	
VAL.BP1	Real	-0.002178	
VAL.CP0	Real	0.0	
VAL.CP1	Real	0.00947	
VAL.CP2	Real	2.4924	
VAL.CP3	Real	0.0	
VAL.DP0	Real	1.4043×10^6	
VAL.DP1	Real	2.9744×10^3	
VAL.DP2	Real	1.4829	
VSAT	Real		cm/s
VSATN	Real		cm/s
VSATP	Real		cm/s
WELL.DELTA	Real	see Table 3-132	eV
WELL.EPS	Real	0	eV
WELL.GAMMA0	Real	2×10^{-3}	eV
WELL.TAUIN	Real	3.3×10^{-13}	s
X.X	Real	1.0	
X.Y	Real	0.0	
X.Z	Real	0.0	
XDIR.ANISO	Logical	False	
Y.X	Real	0.0	
Y.Y	Real	1.0	

Parameter	Type	Default	Units
Y.Z	Real	0.0	
YDIR.ANISO	Logical	False	
ZDIR.ANISO	Logical	True	
Z.SCHENK	Real	1.0	
Z.X	Real	0.0	
Z.Y	Real	0.0	
Z.Z	Real	1.0	
ZAMDMER.Z0	Real	7.0×10^{-7}	cm

Description

The MATERIAL statement is used set basic material parameters related to band structure and parameters for certain mobility, recombination or carrier statistics models. Parameters for temperature dependence are noted in a separate section below.

Localization of Material Parameters

DEVICE	Specifies which device the MATERIAL statement should apply to in MIXEDMODE simulation. The synonym for this parameter is STRUCTURE.
MATERIAL	Specifies which material from the table in Appendix B “Material Systems” that the MATERIAL statement should apply. If a material is specified, then all regions defined as being composed of that material will be affected.

Note: You can specify the following logical parameters to indicate the material instead of assigning the MATERIAL parameter: SILICON, GAAS, POLYSIL, GERMANIU, SIC, SEMICOND, SIGE, ALGAAS, A-SILICO, DIAMOND, HGCDTE, INAS, INGAAS, INP, S.OXIDE, ZNSE, ZNTE, ALINAS, GAASP, INGAP and MINASP.

NAME	Specifies which region the MATERIAL statement should apply. Note that the name must match the name specified in the NAME parameter of the REGION statement or the region number.
REGION	Specifies the region number to which these parameters apply. If there is more than one semiconductor region, specification of different parameters for each region is allowed. If REGION is not specified, all regions in the structure are changed.
STRUCTURE	This is a synonym for DEVICE.

Band Structure Parameters

A.DEFPOT, B.DEFPOT, C.DEFPOT, D.DEFPOT, and U.DEFPOT	Specify the deformation potentials used in calculating the effects of strains on the bandgap of silicon (see Section 3.6.13 “Stress Effects on Bandgap in Si”).
AFFINITY	Specifies the electron affinity.
ALIGN	Specifies the fraction of the bandgap difference that is applied to the conduction band edge, relative to the minimum bandgap material in the device. Note that specifying this parameter overrides any electron affinity specification. See Section 5.1.2 “Alignment” for information on setting the band alignment.
ARICHN	Specifies the effective Richardson constant for electrons.
ARICHP	Specifies the effective Richardson constant for holes.
CHI.EG.TDEP	This is a ratio that specifies what fraction of the change in bandgap due to temperature change ascribed to the electron affinity. CHI.EG.TDEP is not active when ALIGN is specified.
D.TUNNEL	Specifies the maximum tunneling distance for the universal Schottky tunneling model (see Section 3.5.2 “Schottky Contacts”). The alias for this parameter is DIST.SBT .
DEC.DEG	Overrides the default values of dE_c/dE_v given in Table 5-13 .
DEC.C1	This is a conduction band shift for 1st pair of electron valleys.
DEC.C2	This is a conduction band shift for 2nd pair of electron valleys.
DEC.C3	This is a conduction band shift for 3rd pair of electron valleys.
DEC.D2	This is a conduction band shift for Δ2 electron valleys if DEC.C1 is not set.
DEC.D4	This is a conduction band shift for Δ4 electron valleys if DEC.C2 is not set.
DEC.ISO	This is a conduction band shift for isotropic electron band, when NUM.DIRECT=1 .
DEV.HH	This is a valence band shift for heavy holes.
DEV.LH	This is a valence band shift for light holes.
DEV.ISO	This is a valence band shift for isotropic hole band, when NUM.BAND=1 .
DEV.SO	This is a valence band shift for split-off holes.

DIST.SBT	This is an alias for D.TUNNEL.
EG300	Specifies energy gap at 300K (see Equation 3-38). All semiconductor materials in ATLAS must have a defined EG300.
EG1300, EG2300, EG12BOW, EG1ALPH, EG2ALPH, EG1BETA, and EG2BETA	Specify parameters of the General Ternary bandgap model described in Equations 3-42 through 3-44 .
EPS11, EPS12, EPS13, EPS22, EPS23, and EPS33	Specify the strain tensor used in the calculation of the strain effects on bandgap of silicon (see Section 3.6.13 “Stress Effects on Bandgap in Si”).
EPS.XX	XX component of dielectric permittivity tensor used by vector Helmholtz solver.
EPS.YY	YY component of dielectric permittivity tensor used by vector Helmholtz solver.
EPS.ZZ	ZZ component of dielectric permittivity tensor, used by vector Helmholtz solver.
F.BANDCOMP	Specifies the name of a file containing a C-Interpreter function that defines temperature and composition dependent band parameter models.
F.CBDOSFN	Specifies the C-Interpreter file for the Conduction band effective density of states as a function of Lattice/Electron temperature. This function is called cbdosfn.
F.TCAP	Specifies the name of a file containing a C-Interpreter function that defines the lattice thermal capacity as a function of the lattice temperature, position, doping and fraction composition.
F.TCOND	Specifies the name of a file containing a C-Interpreter function that defines the lattice thermal conductivity as a function of the lattice temperature, position, doping and fraction composition.
F.EPSILON	Specifies the name of a file containing a C-Interpreter function that defines temperature and composition dependent static dielectric constant models.
F.FERRO	Specifies the name of a file containing a C-Interpreter function that defines dielectric permittivity as a function of electric field and position (x,y). You need a license to use this parameter.
F.VBDOSFN	Specifies the C-Interpreter file for the Valence band effective density of states as a function of Lattice/Hole temperature. This function is called vbdosfn.

M.DSN	Specifies the electron density of states effective mass. When specified, it is in Equation 3-31 to calculate electron density of states.
M.DSP	Specifies the hole density of states effective mass. When specified it is in Equation 3-32 to calculate hole density of states.
M.VTHN	Specifies the electron effective mass for calculation of thermal velocity in the thermionic heterojunction model (see Equation 5-52).
M.VTHP	Specifies the hole effective mass for calculation of thermal velocity in the thermionic heterojunction model (see Equation 5-53).
ME.SBT and MH.SBT	These are aliases for ME.TUNNEL and MH.TUNNEL .
ME.TUNNEL and MH.TUNNEL	Specify the electron and hole effective masses for tunneling used in the universal Schottky tunneling model (see Section 3.5.2 “Schottky Contacts”). The aliases for these parameters are ME.SBT and MH.SBT .
NC.F	Specifies the conduction band density of states temperature (see Equation 3-31).
NV.F	Specifies the valence band density of states temperature (see Equation 3-32).
NC300	Specifies the conduction band density at 300K. (see Equation 3-31).
NI.MIN	Specifies the minimum allowable value of the intrinsic carrier density.
NV300	Specifies valence band density at 300K (see Equation 3-32).
PERMITTIVITY	Specifies dielectric permittivity of the material. All materials in an ATLAS structure must have a defined permittivity.

BQP Parameters

BQP.NGAMMA and BQP.PGAMMA	These parameters allow you to set the γ parameter of the BQP model for electrons and holes respectively.
BQP.NALPHA and BQP.PALPHA	These parameters allow you to set the α parameter of the BQP model for electrons and holes respectively.

Mobility Model Parameters

F.CONMUN	Specifies the name of a file containing a C-Interpreter function for the specification of temperature, composition and doping dependent electron mobility models.
F.CONMUP	Specifies the name of a file containing a C-Interpreter function for the specification of temperature, composition and doping dependent hole mobility models.
F.ENMUN	Specifies a C-Interpreter file for the electron mobility as a function of Electron Temperature and perpendicular field as well as other choice variables. The function itself is named <code>endepmun</code> and only applies to ATLAS2D.
F.ENMUP	Specifies a C-Interpreter file for the hole mobility as a function of Hole Temperature and perpendicular field as well as other choice variables. The function itself is named <code>endepmup</code> and only applies to ATLAS2D.
F.MUNSAT	Specifies the name of a file containing a C-Interpreter function for the specification of parallel field dependent electron mobility model for velocity saturation.
F.MUPSAT	Specifies the name of a file containing a C-Interpreter function for the specification of parallel field dependent hole mobility model for velocity saturation.
F.VSATN	Specifies the name of a file containing a C-Interpreter function for the specification of temperature and composition dependent electron saturation velocity models.
F.VSATP	Specifies the name of a file containing a C-Interpreter function for the specification of temperature and composition dependent hole saturation velocity models.
GSURF	Specifies a factor by which mobility is reduced at the semiconductor surface. This is a simple but not accurate alternative to the transverse field dependent or surface mobility models set on the <code>MODEL\$</code> statement.
MUN	Specifies low-field electron mobility. This parameter is only used if no concentration dependent mobility model is specified.
MUP	Specifies low-field hole mobility. This parameter is only used if no concentration dependent mobility model is specified.
VSATURATION	Specifies the saturation velocity for the electric field dependent mobility.
VSATN	Specifies the saturation velocity for electrons.
VSATP	Specifies the saturation velocity for holes.

Recombination Model Parameters

A.2D.LANGEVIN	Specifies the prefactor for the Juska 2D Langevin recombination model. See Equation 15-34 .
A.LANGEVIN	Specifies the prefactor for the bimolecular Langevin recombination model. See Equation 15-32 .
A.TRAPCOULOMBIC B.TRAPCOULOMBIC	Specify the Poole-Frenkel thermal emission enhancement factor parameters. See Equations 3-90 and 3-91 .
ALPHA.2D.LANGEVIN	Specifies the prefactor for the Juska 2D Langevin recombination model. See Equation 15-35 .
AN, AP, BN, BP, CN, EN, and EP	The parameter for the concentration dependent lifetime model (see Equations 3-309 and 3-310).
AUG.CNL AUG.CPL AUG.CHI	Specify the coefficients for the carrier and doping concentration dependent Auger rate coefficient models described in Equations 3-352 and 3-353 .
AUGN	Specifies the Auger coefficient, <i>cn</i> (see Equation 3-343).
AUGP	Specifies the Auger coefficient, <i>cp</i> (see Equation 3-343).
AUGKN	The parameter of the narrow band-gap electron Auger recombination coefficient model.
AUGKP	The parameter of the narrow band-gap electron Auger recombination coefficient model.
BB.A, BB.B, and BB.GAMMA	Specify the band-to-band tunneling parameters (see Equation 3-429).
BBT.ALPHA	Specifies the scaling factor in the Hurkx band-to-band tunneling model (see Equation 3-437).
C.DIRECT	This is an alias for COPT.

See [Equations 3-319](#) thru [3-322](#) to see how the following CDL parameters are used.

CDL.ETR1 and CDL.ETR2	There are the trap energy levels in the Coupled Defect Level model. They are relative to the intrinsic energy level and are in Electron Volts.
CDL.TN1, CDL.TN2, CDL.TP1, and CDL.TP2	These are the recombination lifetimes for the two energy levels in the Coupled Defect Level model.
CDL.COUPLING	Specifies the coupling constant in units of $\text{cm}^{-3}\text{s}^{-1}$ for the Coupled Defect Level model.

COPT	Specifies the optical recombination rate for the material. This parameter has no meaning unless MODELS OPTR has been specified (see Equation 3-339). The alias for this parameter is C.DIRECT.
ETRAP	Specifies the trap energy for SRH recombination
F.BBT	Specifies the name of a file containing a C-INTERPRETER function for the specification of the electric field and carrier concentration dependent band-to-band generation rate.
F.COFT	Specifies the name of a file containing a C-INTERPRETER function for the specification of composition and temperature dependence of the radiative recombination rate.
F.GAUN	Specifies the name of a file containing a C-INTERPRETER function for the specification of composition and temperature dependence of the electron Auger coefficient.
F.GAUP	Specifies the name of a file containing a C-INTERPRETER function for the specification of composition and temperature dependence of the hole Auger coefficient.
F.RECOMB	Specifies the name of a file containing a C-Interpreter function for the specification of temperature, composition, electron and hole concentration dependent recombination rate models.
F.TAUN	Specifies the name of a file containing a C-INTERPRETER function for the specification of position dependent electron lifetime models.
F.TAUP	Specifies the name of a file containing a C-INTERPRETER function for the specification of position dependent hole lifetime models.
F.TAURN	Specifies the name of a file containing a C-INTERPRETER function specifying the electron relaxation time as a function of electron energy.
F.TAURP	Specifies the name of a file containing a C-INTERPRETER function specifying the hole relaxation time as a function of hole energy.
G.2D.LANGEVIN	Specifies the prefactor for the Juska 2D Langevin recombination model. See Equations 15-34 and 15-35 .
HNS.AE , HNS.BE , HNS.CE , HNS.AH , HNS.BH , and HNS.CH	These are the temperature dependence parameters for HNSAUG model (see Equations 3-356 and 3-357).
HNS.HE and HNS.NOE	These are the Electron concentration dependence parameters for HNSAUG model (see Equations 3-356 and 3-357).

HNS.HH and HNS.NOH	These are the Hole concentration dependence parameters for HNSAUG model (see Equations 3-356 and 3-357).
JTAT.M2	Matrix element squared for TRAP.JTAT model.
L.2D.LANGEVIN	Specifies the prefactor for the Juska 2D Langevin recombination model. See Equation 15-37.
N.SCH.MIN P.SCH.MIN N.SCH.MAX P.SCH.MAX N.SCH.GAMMA P.SCH.GAMMA N.SCH.NREF P.SCH.NREF	These are used in the Scharfetter doping concentration dependent lifetime model. They are applied in Equations 3-313 and 3-314.
TCOEFF.N and TCOEFF.P	These are used in the alternative lifetime lattice temperature dependence model.
TAA.CN and TAA.CP	These are used in the carrier concentration dependent recombination lifetime model of Equations 3-323 and 3-324.
ZAMDMER.Z0	The nominal spatial separation of recombination centers in the ZAMDMER model of electron trap lifetime in LT-GaAs.

Impact Ionization Parameters

AN0.VALD	This is an alias for VAL.AN0.
AN1.VALD	This is an alias for VAL.AN1.
AN2.VALD	This is an alias for VAL.AN2.
AP0.VALD	This is an alias for VAL.AP0.
AP1.VALD	This is an alias for VAL.AP1.
AP2.VALD	This is an alias for VAL.AP2.
BETAN	This is for electrons and BETAP for holes correspond to coefficients for the power of ECRIT/E. The aliases for these parameters are EXN.II and EXP.II.
BN0.VALD	This is an alias for VAL.BN0.
BN1.VALD	This is an alias for VAL.BN1.
BP0.VALD	This is an alias for VAL.BP0.
BP1.VALD	This is an alias for VAL.BP1.
CN2, CP2, DN2, and DP2	These are specifiable coefficients in the temperature dependent models described in Equations 3-371 and 3-372. The aliases for these parameter are N.ION.1, P.ION.1, N.ION.2, and P.ION.2.

CN0.VALD	This is an alias for VAL.CN0.
CN1.VALD	This is an alias for VAL.CN1.
CN2.VALD	This is an alias for VAL.CN2.
CN3.VALD	This is an alias for VAL.CN3.
CP0.VALD	This is an alias for VAL.CP0.
CP1.VALD	This is an alias for VAL.CP1.
CP2.VALD	This is an alias for VAL.CP2.
CP3.VALD	This is an alias for VAL.CP3.
DN0.VALD	This is an alias for VAL.DN0.
DN1.VALD	This is an alias for VAL.DN1.
DN2.VALD	This is an alias for VAL.DN2.
DP0.VALD	This is an alias for VAL.DP0.
DP1.VALD	This is an alias for VAL.DP1.
DP2.VALD	This is an alias for VAL.DP2.
ECN.II	This is an alias for BN2.
ECP.II	This is an alias for BP2.
EXN.II	This is an alias for BETAN.
EXP.II	This is an alias for BETAP.
LAMBDAE	Specifies the mean free path for electrons. The alias for this parameter is LAN300.
LAMDAH	Specifies the mean free path for holes. The alias for this parameter is LAP300.
LAN300	This is an alias for LAMBDAE.
LAP300	This is an alias for LAMDAH.
N.ION.1 P.ION.1 N.ION.2 P.ION.2	These are the aliases for CN2, CP2, DN2 and DP2.
N.IONIZA	This is an alias for AN2.
OP.PH.EN	This is an alias for OPPHE.
OPPH	Specifies the optical phonon energy. The alias for this parameter is OP.PH.EN.
P.IONIZA	This is an alias for AP2.

VAL.AN0	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-382 . The alias for this parameter is AN0.VALD.
VAL.AN1	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-382 . The alias for this parameter is AN1.VALD.
VAL.AN2	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-382 . The alias for this parameter is AN2.VALD.
VAL.BN0	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-383 . The alias for this parameter is BN0.VALD.
VAL.BN1	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-383 . The alias for this parameter is BN1.VALD.
VAL.CN0	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-384 . The alias for this parameter is CN0.VALD.
VAL.CN1	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-384 . The alias for this parameter is CN1.VALD.
VAL.CN2	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-384 . The alias for this parameter is CN2.VALD.
VAL.CN3	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-384 . The alias for this parameter is CN3.VALD.
VAL.DN0	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-385 . The alias for this parameter is DN0.VALD.
VAL.DN1	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-385 . The alias for this parameter is DN1.VALD.
VAL.DN2	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-385 . The alias for this parameter is DN2.VALD.
VAL.AP0	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-386 .
VAL.AP1	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-386 . The alias for this parameter is AP1.VALD.
VAL.AP2	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-386 . The alias for this parameter is AP2.VALD.
VAL.BP0	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-387 . The alias for this parameter is BP0.VALD.
VAL.BP1	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-387 . The alias for this parameter is BP1.VALD.
VAL.CP0	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-388 . The alias for this parameter is CP0.VALD.
VAL.CP1	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-388 . The alias for this parameter is CP1.VALD.

VAL.CP2	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-388 . The alias for this parameter is CP2.VALD.
VAL.CP3	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-388 . The alias for this parameter is CP3.VALD.
VAL.DP0	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-389 . The alias for this parameter is DP0.VALD.
VAL.DP1	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-389 . The alias for this parameter is DP1.VALD.
VAL.DP2	Specifies the value of a temperature dependent impact ionization parameter in Equation 3-389 . The alias for this parameter is DP2.VALD.

Klaassen Model parameters

KSRHTN	Coefficient for Klaassen's concentration and temperature dependent SRH lifetime model.
KSRHTP	Coefficient for Klaassen's concentration and temperature dependent SRH lifetime model.
KSRHCN	Coefficient for Klaassen's concentration and temperature dependent SRH lifetime model.
KSRHCP	Coefficient for Klaassen's concentration and temperature dependent SRH lifetime model.
KSRHGN	Coefficient for Klaassen's concentration and temperature dependent SRH lifetime model.
KSRHGP	Coefficient for Klaassen's concentration and temperature dependent SRH lifetime model.
KAUGCN	Coefficient for Klaassen's concentration dependent Auger model.
KAUGCP	Coefficient for Klaassen's concentration dependent Auger model.
KAUGDN	Coefficient for Klaassen's concentration dependent Auger model.
KAUGDP	Coefficient for Klaassen's concentration dependent Auger model.
NSRHN	Specifies the SRH concentration parameter for electrons (see Equation 3-309).
NSRHP	Specifies the SRH concentration parameter for holes (see Equation 3-310).
TAUN0	Specifies SRH lifetime for electrons (see Equation 3-309).
TAUP0	Specifies SRH lifetime for holes (see Equation 3-310).

See also [Equations 3-311](#) and [3-312](#) and [Equations 3-344](#) and [3-346](#) for more information about Klaassen models.

Carrier Statistics Model Parameters

ASYMMETRY	Specifies the relative degree where band gap narrowing applies to the conduction band versus the valence band. The value of the ASYMMETRY parameter is multiplied by the total change in band gap due to band gap narrowing and that product is applied to the conduction band edge. For example, if the ASYMMETRY parameter has a value of 1.0, then the change in band gap due to band gap narrowing is applied only to the conduction band edge and the valence band edge remains unaffected.
BGN.E BGN.N BGN.C	Specify the parameters of the band gap narrowing model given in Equation 3-46 . The aliases for these parameters are V0.BGN, N0.BGN, and CON.BGN. BGN.E and BGN.N are also used in the Bennett-Wilson and del Alamo Bandgap narrowing models (see Equations 3-51 and 3-52).
CON.BGN	This is an alias for BGN.C.
EAB	Specifies acceptor energy level (see Equation 3-55).
EDB	Specifies donor energy level (see Equation 3-54).
F.BGN	Specifies the name of a file containing a C-INTERPRETER function for the specification of temperature, composition and doping dependent bandgap narrowing models.
GCB	Specifies the conduction-band degeneracy factor (see Equation 3-54).
GVB	Specifies the valence-band degeneracy factor (see Equation 3-55).
N0.BGN	This is an alias for BGN.N.
V0.BGN	This is an alias for BGN.E.

Energy Balance Parameters

TAUMOB.EL	Specifies the relaxation time for electrons in the temperature dependent mobility model (see Equation 3-138).
TAUMOB.HO	Specifies the relaxation time for holes in the temperature dependent mobility model (see Equation 3-139).
TAUREL.EL	Specifies the relaxation time for electrons in the energy balance model (see Equation 3-132).
TAUREL.HO	Specifies the relaxation time for holes in the energy balance model (see Equation 3-133).
TRE.T1, TRE.T2, TRE.T3, TRE.W1, TRE.W2, TRE.W3, TRH.T1, TRH.T2, TRH.T3, TRH.W1, TRH.W2, and TRH.W3	These are used in the temperature dependent energy relaxation time model based on table data from Laux-Fischetti Monte-Carlo simulation (see Table 3-17).

Hot Carrier Injection Parameters

IG.ELINR	Specifies the electron mean free path between redirecting collisions. The alias for this parameter is LAMRN.
IG.HLINR	Specifies the hole mean free path between redirecting collisions. The alias for this parameter is LAMRP.
IG.ELINF	Specifies the electron mean free path length for scattering by optical phonons. The alias for this parameter is LAMHN.
IG.HLINF	Specifies the hole mean free path length for scattering by optical phonons. The alias for this parameter is LAMHP.
LAMRN	This is an alias for IG.ELINR.
LAMRP	This is an alias for IG.HLINR.
LAMHN	This is an alias for IG.ELINF.
LAMHP	This is an alias for IG.HLINF.

Lattice Temperature Dependence Parameters

A.PASSLER	Specifies a parameter of the Passler temperature dependent bandgap model given in Equation 3-39 .
EGALPHA	Specifies the alpha coefficient for temperature dependence of bandgap (see Equation 3-38).
EGBETA	Specifies the beta coefficient for temperature dependence of bandgap (see Equation 3-38).
F.PDN	Uses C-Interpreter function for phonon drag contribution to the electron thermopower.
F.PDP	Uses C-Interpreter function for phonon drag contribution to the hole thermopower.
HC.A, HC.B, HC.C, and HC.D	Specify the values of the four coefficient of the heat capacity equation (see Equation 7-6).
HC.BETA, HC.C1, HC.C300, and HC.RHO	Specify user overrides for the parameters of Equation 7-7 .
LT.TAUN	Specifies the temperature dependence for electron lifetimes (see Equation 7-31).
LT.TAUP	Specifies the temperature dependence for hole lifetimes (see Equation 7-32).
P.PASSLER	Specifies a parameter of the Passler temperature dependent bandgap model given in Equation 3-39 .

PCM.AEA	Specifies the activation energy for amorphization of a phase change material.
PCM.AP	Specifies the time exponent for amorphous change of a phase change material (see Section 7.2.9 “Phase Change Materials (PCMs)”).
PCM.ARHO	Specifies the amorphous resistivity of a phase change material (see Section 7.2.9 “Phase Change Materials (PCMs)”).
PCM.ATC	Specifies the critical temperature for amorphous change of a phase change material (see Section 7.2.9 “Phase Change Materials (PCMs)”).
PCM.CEA	Specifies the activation energy for crystallization of a phase change material.
PCM.CP	Specifies the time exponent for crystallization of a phase change material (see Section 7.2.9 “Phase Change Materials (PCMs)”).
PCM.CRHO	Specifies the crystalline resistivity of a phase change material (see Section 7.2.9 “Phase Change Materials (PCMs)”).
PCM.CTC	Specifies the critical temperature for crystallization of a phase change material (see Section 7.2.9 “Phase Change Materials (PCMs)”).
PCM.ATAU	Specifies the time constant for amorphous change of a phase change material (see Section 7.2.9 “Phase Change Materials (PCMs)”).
PCM.CTAU	Specifies the time constant for crystallization of a phase change material (see Section 7.2.9 “Phase Change Materials (PCMs)”).
PCM.LATHEAT	Specifies the latent of change from crystalline to amorphous state in a phase change material (see Section 7.2.9 “Phase Change Materials (PCMs)”).
PDA.N	Specifies the value of a parameter in the model of phonon drag contribution to the electron thermopower (see Equation 7-13).
PDA.P	Specifies the value of a parameter in the model of phonon drag contribution to the hole thermopower (see Equation 7-14).
PDEXP.N	Specifies the value of a parameter in the model of phonon drag contribution to the electron thermopower (see Equation 7-13).
PDEXP.P	Specifies the value of a parameter in the model of phonon drag contribution to the hole thermopower (see Equation 7-14).
POWER	Specifies the value of thermal power generated in a power source associated with a region in THERMAL3D (see Chapter 17 “Thermal 3D: Thermal Packaging Simulator”).
T.PASSLER	Specifies a parameter of the Passler temperature dependent bandgap model given in Equation 3-39 .

TC.A, TC.B, and TC.C	Specify the three thermal conductivity coefficients (see Table 7-1).
TC.CONST	Specifies the equilibrium value of thermal conductivity, $k(T_0)$, in Table 7-1 . The synonym for this parameter is TC.CONST. TC.0 is an alias for TC.CONST.
TC.D	Specifies the value of the parameter D in Table 7-1 .
TC.E	Specifies the value of the parameter E in Table 7-1 .
TCON.CONST	Specifies that thermal conductivity should be modeled as constant with respect to temperature. The value of the thermal conductivity is given by the value of the TC.C0 parameter.
TCON.POWER	Specifies that the temperature dependence of thermal conductivity should be modeled using Table 7-1 .
TCON.POLY	Specifies that the temperature dependence of thermal conductivity should be modeled using Table 7-1 .
TCON.RECIP	Specifies that the temperature dependence of thermal conductivity should be modeled using Table 7-1 .
TC.NPOW	Specifies the value of the coefficient of temperature dependence of thermal conductivity, n , in Table 7-1 .
TMUN and TMUP	Specify the lattice temperature coefficients for the temperature dependence of electron lattice mobility, and of hole lattice mobility respectively.
UBGN.B and UBGN.C	Define the numerical values of the fitting parameters for Equation 3-50 .

Oxide Material Parameters

INSULATOR	Specifies that a semiconductor region is to be treated as an insulator.
OXCH.ONLY	Specifies that electron and hole concentrations are omitted from Poisson's Equation in oxides.
SEMICONDUC	Specifies that an oxide region is to be treated as a semiconductor.

Photogeneration Parameters

A1.RAJ, A2.RAJ, and AD.RAJ	Specify parameters for Equation 3-598 .
AADACHI, BADACHI, and DADACHI	These are the parameters for Adachi's refractive index model. See Equation 3-675 .
BETA.RAJ GAMMA.RAJ	Specify parameters in Equations 3-599 through 3-601 .

C1.RAJ and C2.RAJ	Specify parameters of Equation 3-598 .
E.CONDUC	Specifies the electric conductivity in all directions in mho/cm.
EG1.RAJ , EG2.RAJ , and EGD.RAJ	Specify parameters of Equations 3-599 through 3-601 .
F.INDEX	Specifies the name of a file containing a C-INTERPRETER function for the specification of wavelength dependent complex index of refraction models.
J.ELECT	Specifies the electric current density in all directions in A/cm ² .
J.MAGNET	Specifies the equivalent magnetic current density in all directions in V/cm ² .
HNU1 and HNU2	These are used to specify the range of energies over which to plot the complex index of refraction. You also should specify NHNU and OUT.INDEX .
IMAG.INDEX	Specifies the imaginary portion of the refractive index of the semiconductor (see Equation 10-12). Wavelength dependent defaults exist for certain materials as documented in Appendix B “Material Systems” .
INDEX.FILE	Specifies the filename of an ASCII file from which complex refractive indices for a material are read. See Section 10.8.2 “Setting A Wavelength Dependent Refractive Index” for more information.
INDX.IMAG	Specifies the name of a file analogous to INDEX.FILE described above with only two columns wavelength and imaginary index. See Section 10.8.2 “Setting A Wavelength Dependent Refractive Index” for more information.
INDX.REAL	Specifies the name of a file analogous to INDEX.FILE described above with only two columns wavelength and real index. See Section 10.8.2 “Setting A Wavelength Dependent Refractive Index” for more information.
LAM1 and LAM2	These are used to specify the range of wavelengths over which to plot the complex index of refraction. You also should specify NLAM and OUT.INDEX .
MAG.LOSS	Specifies the equivalent magnetic loss in all directions in Ω/cm.
NDX.ADACHI	Enables Adachi's refractive index model. See Equation 3-675 .
N.ANISO	Specifies that the region will simulated in FDTD with an anisotropic index of refraction described by the parameters N.XX , N.YY , N.ZZ , N.ALPHA , N.BETA , and N.GAMMA .
N.XX , N.YY , and N.ZZ	Specify the anisotropic indices of refraction along the principal crystalline axes.
N.ALPHA , N.BETA , and N.GAMMA	Specify the Euler angles describing the relative orientation between the crystal and the optical axis for anisotropic index of refraction in FDTD.
NDX.SELLMEIER	Enables Sellmeier's refractive index model. See Equation 3-674 .
NHNU	Specifies the number of energy samples between HNU1 and HNU2 to plotting the complex index of refraction.

NK.EV	Specifies that wavelengths included in index files specified by INDEX.FILE, INDEX.IMAG or INDEX.REAL should be interpreted as energies in units of electron volts.
NK.NM	Specifies that wavelengths included in index files specified by INDEX.FILE, INDEX.IMAG or INDEX.REAL should be interpreted as having units of nanometers.
NLAM	Specifies the number of wavelength samples between LAM1 and LAM2 to plotting the complex index of refraction.
OUT.INDEX	Specifies the root file name for output of wavelength dependent samples of complex index of refraction suitable for display in TONYPLOT (Section 10.8 “Defining Optical Properties of Materials”).
PERMEABILITY	Specifies the relative permeability.
S0SELL, S1SELL, S2SELL, L1SELL, and L2SELL	These are parameters for Sellmeier's refractive index model. See Equation 3-674 .
TLU.A, TLU.C, TLC.E0, TLU.EC, TLU.EG, and TLU.EPS	These are used to specify the parameters of the Tauc-Lorentz dielectric function model for complex index of refraction described in Section 3.10.3 “Tauc-Lorentz Dielectric Function with Optional Urbach Tail Model for Complex Index of Refraction”

Note: The index file must be ordered by increasing wavelength.

REAL.INDEX	Specifies the real portion of the refractive index of the semiconductor. Wavelength dependent defaults exist for certain materials as documented in Appendix B “Material Systems” .
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LASER Parameters

ABSORPTION.SAT	Specifies the absorption saturation intensity used in the non-linear absorption loss model given in Equation 8-39 .
ALPHAA	Specifies the bulk absorption coefficient in Equation 8-17 .
ALPHAR	Specifies the line width broadening factor in Equation 8-18 .
EMISSION.FACTOR	Specifies a scale factor accounting the proportion of light directionally coupled into the lasing mode.
EPSINF	Specifies the high frequency relative dielectric permittivity (ϵ_∞) (see Equation 8-17). If this parameter is not specified, it will be set equal to the static dielectric permittivity of the material.
F.ALPHAA	Specifies the name of a file containing a C-INTERPRETER function for the bulk absorption coefficient.

FC.RN	This is the free-carrier loss model parameter in Equation 8-19 .
FC.RP	This is the free-carrier loss model parameter in Equation 8-20 .
GAIN.SAT	Specifies the non-linear gain saturation factor used in Equation 8-38 .
GAIN0	Specifies the parameter in Sections 3.9.2 “The Default Radiative Recombination Model” and 3.9.3 “The Standard Gain Model” .
GAIN00	Specifies the parameter in Section 3.9.4 “The Empirical Gain Model” .
GAIN1N	Specifies the parameter in Section 3.9.4 “The Empirical Gain Model” .
GAIN1P	Specifies the parameter in Section 3.9.4 “The Empirical Gain Model” .
GAIN1MIN	Specifies the parameter in Section 3.9.4 “The Empirical Gain Model” .
GAIN2NP	Specifies the parameter in Section 3.9.4 “The Empirical Gain Model” .
GAMMA	Specifies the parameter in Sections 3.9.2 “The Default Radiative Recombination Model” and 3.9.3 “The Standard Gain Model” . If this parameter is not specified, it will be calculated using Equation 3-608 .
GN1	Specifies the parameter in Section 3.9.5 “Takayama's Gain Model” .
GN2	Specifies the parameter in Section 3.9.5 “Takayama's Gain Model” .
NTRANSPARENT	Specifies the parameter in Section 3.9.5 “Takayama's Gain Model” .

NOISE Parameters

F.MNSNDIFF	Specifies the name of a file containing a C-Interpreter function for the microscopic noise source for electron diffusion noise.
F.MNSPDIFF	Specifies the name of a file containing a C-Interpreter function for the microscopic noise source for hole diffusion noise.
F.MNSNFLICKER	Specifies the name of a file containing a C-Interpreter function for the microscopic noise source for electron flicker noise.
F.MNSPFLICKER	Specifies the name of a file containing a C-Interpreter function for the microscopic noise source for hole flicker noise.
HOOGEN	Specifies the Hooge constant for electron flicker noise.
HOOGEP	Specifies the Hooge constant for hole flicker noise.

Organic Transport Parameters

HOPN.BETA	Specifies the percolation constant for electrons.
HOPN.GAMMA	Specifies 1/carrier localization radius for electrons.
HOPN.V0	Specifies the attempt-to-jump frequency for electrons.
HOPP.BETA	Specifies the percolation constant for holes.
HOPP.GAMMA	Specifies 1/carrier localization radius for holes.
HOPP.V0	Specifies the attempt-to-jump frequency for holes.

Exciton Material Parameters

A.SINGLET	Specifies the singlet electron hole separation distance used in Equation 15-33 .
DKCQ.EXCITON	Specifies the dopant concentration quenching rate.
DKNRS.EXCITON	Specifies the dopant non-radiative decay rate.
DKSS.EXCITON	Specifies the dopant bimolecular annihilation constant.
DOPE.SPECT	Specifies the file name of a second user defined spectrum file. See also USER.SPECT .
DPHEFF.EXCITON	Specifies the dopant photoluminescence quantum efficiency.
DRST.EXCITON	Specifies the fraction of dopant singlets formed.
DTAUS.EXCITON	Specifies the dopant singlet radiative decay lifetime.
K.SINGLET	Specifies the coulombic relation between S.BINDING and A.SINGLET as described in Equation 15-72 .
KISC.EXCITON	Specifies the exciton intersystem crossing constant.
KNRS.EXCITON	Specifies the singlet non-radiative decay constant.
KNRT.EXCITON	Specifies the triplet non-radiative decay constant.
KSP.EXCITON	Specifies the singlet-polaron constant.
KSS.EXCITON	Specifies the singlet-singlet constant.
KST.EXCITON	Specifies the singlet-triplet constant.
KTP.EXCITON	Specifies the triplet-polaron constant.
KTt.EXCITON	Specifies the triplet-triplet constant.
LDS.EXCITON	Specifies the singlet diffusion length. The synonym for this parameter is LD.EXCITON .
LDT.EXCITON	Specifies the triplet diffusion length.

OUT.DSPEC	Specifies the TONYPLOT compatible file name associated with the DOPE.SPECT parameter.
OUT.USPEC	Specifies the TONYPLOT compatible file name associated with the USER.SPECT parameter.
PHEFF.EXCITON	Specifies the photoluminescence quantum efficiency for the host material.
QE.EXCITON	Specifies the fraction of electron-hole photogeneration rate that goes to the generation of excitons.
QR.EXCITON	Specifies the quenching rate per unit metal density for electrode quenching.
RST.EXCITON	Specifies the fraction of singlets formed during Langevin recombination.
RST.TT.EXCITON	Specifies the fraction of singlets formed during triplet-triplet annihilation.
S.BINDING	Specifies the singlet binding energy used in Equation 15-33 .
TAUS.EXCITON	Specifies the singlet radiative decay lifetime. The synonym for this parameter is TAU.EXCITON.
TAUT.EXCITON	Specifies the triplet radiative decay lifetime.
USER.SPECT	Specifies the file name of a user-defined spectrum file used during reverse raytrace. You can define a second user definable spectrum file using the DOPE.SPECT parameter.

Miscellaneous Material Parameters

A1, A2, A3, A4, A5, and A6	Specify valence band effective mass parameters.
AC, AV, and BBB	Specify cubic deformation potentials.
ALATTICE	Specifies the in plane lattice constant.
ASTR, BSTR, CSTR, DSTR, ESTR, and FSTR	These are user-definable parameters of the equations for heavy and light hole masses in Ishikawa's strain model (see Section 3.9.12 "Ishikawa's Strain Effects Model").
C11, C12, C13, and c33	Specify the elastic stiffness coefficients.
D0.H1	Diffusion coefficient for atomic hydrogen.
D0.H2	Diffusion coefficient for molecular hydrogen.
DEGENERACY	Specifies the spin degeneracy.
DELTA1, DELTA2, and DELTA3	Specify the valence band energy splits.
DGN.GAMMA and DGP.GAMMA	Specify the electron and hole tuning parameters for density gradient modeling.
DINDEXDT	Specifies the temperature coefficient of the index of refraction.

DRHODT	Specifies the temperature coefficient of conductor resistivity.
D1, D2, D3, and D4	Specify shear deformation potentials.
E31, E33, and PSP	Specify piezo-electric constants.
EA.H1	Activation energy for atomic hydrogen diffusion
EA.H2	Activation energy for molecular hydrogen diffusion.
EMISS.EFFI	Specifies the number of photons emitted per photon absorbed for frequency conversion materials (see Section 10.11 “Frequency Conversion Materials (2D Only)”).
EMISS.LAMB	Specifies the emission wavelength of the frequency conversion material described in (see Section 10.11 “Frequency Conversion Materials (2D Only)”).
EMISS.NANG	Specifies the number of angles evenly spaced around a circle of 360° in which emission centers emit light.
EMISS.NX	Specifies the number of emission centers in the x direction in a frequency conversion material.
EMISS.NY	Specifies the number of emission centers in the y direction in a frequency conversion material.
EMISS.WIDE	Specifies the width of each ray emitted in a frequency conversion material.
EP.MBULK	This is an energy parameter used to calculate the momentum matrix element (see Equation 3-611).
F.MAX and F.MIN	Specify the electric field range for outputting certain models for plotting in TONYPLOT.
F.NUMBER	Specifies the number of field samples used to output certain field dependent models for plotting in TONYPLOT.
FB.MBULK	This is a correction factor used to calculate the momentum matrix element (see Equation 3-611).
H1TOH2RATE	Hydrogen dimerisation rate.
H2TOH1RATE	Molecular hydrogen dissociation rate.
H1SRV	Atomic hydrogen surface recombination velocity at device exterior.
H2SRV	Molecular hydrogen surface recombination velocity at device exterior.
HUANG.RHYS	This is a parameter of the Schenk trap assisted tunneling model.
IF.CHAR	Specifies the Gaussian characteristic distance for spreading polarization charges away from the interface.

IINOFF and IIPOFF	Specify file names for outputting electron and hole ionization rate versus electric field for plotting in TONYPLOT. Note: You should also specify F . MIN, F . MAX, and NUM . F
LUTT1 , LUTT2 , and LUTT3	Specify the luttinger parameters.
M.VTHN and M.VTHP	Specify the electron and hole effective masses used for calculation of thermal velocity.
MBULKSQ	This is the momentum matrix element.
MC	Specifies the conduction band effective mass.
MINIMA	Specifies the number of equivalent minima in the conduction band energy.
MHH	Specifies the heavy hole effective mass.
ML	Specifies the conduction band longitudinal effective mass.
MLH	Specifies the light hole effective mass.
MSO	Specifies the split off (crystal lattice) effective mass.
MSTAR	Specifies the conduction band effective mass dispersion used in Equation 3-611 .
MTT	Specifies the transverse effective mass (wurtzite).
MT1 and MT2	Specify the transverse effective masses (zincblende).
MUNOFF and MUPOFF	Specify file names for writing electron and hole mobility field characteristics for plotting in TONYPLOT.
MV	Specifies the valence band effective mass.
MZZ	Specifies the effective mass along the crystal axis (wurtzite).
PHONON.ENERGY	This is a parameter of the Schenk trap assisted tunneling model.
PIP.OMEGA	This is the phonon energy in eV for the Pipinys model.
PIP.ACC	This is the electron-phonon interaction constant for the Pipinys model.
PIP.ET	This is the trap depth in eV for the Pipinys model.
PIP.NT	This is the occupied interface state density for the Pipinys model.
PSP	Specifies the spontaneous polarization.
RESISTIVITY	Specifies the resistivity of conductor regions.
SO.DELTA	Specifies the spin orbital splitting energy in a quantum well. The alias for this parameter is WELL.DELTA .

SOPRA	Identifies the name of a file from the SOPRA database. See Section B.13.1 “SOPRA Database”
SPECIES1.AF	Attempt frequency for ionic species 1 diffusion coefficient (see Section 3.16 “Generic Ion Transport Model”).
SPECIES1.EA	Activation energy for ionic species 1 diffusion coefficient (see Section 3.16 “Generic Ion Transport Model”).
SPECIES1.HOP	Hopping distance for ionic species 1 diffusion coefficient (see Section 3.16 “Generic Ion Transport Model”).
SPECIES2.AF	Attempt frequency for ionic species 2 diffusion coefficient (see Section 3.16 “Generic Ion Transport Model”).
SPECIES2.EA	Activation energy for ionic species 2 diffusion coefficient (see Section 3.16 “Generic Ion Transport Model”).
SPECIES2.HOP	Hopping distance for ionic species 2 diffusion coefficient (see Section 3.16 “Generic Ion Transport Model”).
SPECIES3.AF	Attempt frequency for ionic species 3 diffusion coefficient (see Section 3.16 “Generic Ion Transport Model”).
SPECIES3.EA	Activation energy for ionic species 3 diffusion coefficient (see Section 3.16 “Generic Ion Transport Model”).
SPECIES3.HOP	Hopping distance for ionic species 3 diffusion coefficient (see Section 3.16 “Generic Ion Transport Model”).
STABLE	Specifies the selected strain table for the Ishikawa strain effects model. See Section 3.9.12 “Ishikawa’s Strain Effects Model” .
TE.MODES	Specifies whether TE or TM modes will be used for calculation of asymmetry factors for the LI model.
USER.DEFAULT	Specifies which material the user-defined material should use for its default parameters.
USER.GROUP	Specifies the material group for the user-defined material. USER.GROUP can be either SEMICONDUCTOR, INSULATOR, or CONDUCTOR.
WELL.EPS	Specifies the high frequency permittivity used in calculating gain and radiative recombination in a quantum well.
WELL.GAMMA0	Specifies the Lorentzian gain broadening factor from Section 3.9.11 “Lorentzian Gain Broadening” .
WELL.TAUIN	Specifies the Lorentzian gain broadening factor from Section 3.9.11 “Lorentzian Gain Broadening” .
Z.SCHENK	This is a parameter of the Schenk trap assisted tunneling model.

Conductor Parameters

DRHODT	Specifies the temperature coefficient of resistivity in $\mu\text{W}\cdot\text{cm}/\text{K}$.
RESISTIVITY	Specifies the material resistivity in $\mu\text{W}\cdot\text{cm}$.

Defect Generation Material Parameters

KD.LID	Specifies the light induced SiHD creation constant. See Equation 14-52 .
KH.LID	Specifies the disassociation constant of a hyrdogen atom from a SiHD defect. See Equation 14-52 .
SIGLID	Specifies the capture coefficient of free carriers by dangling bonds. See Equation 14-52 .

Material Coefficient Definition Examples

Numbered region

This example specifies SRH lifetimes and concentration independent low-field mobilities for region number 2. All other parameters use default values and parameters in other regions are unaffected.

```
MATERIAL TAUN0=5.0E-6 TAUP0=5.0E-6 MUN=3000 MUP=500 REGION=2
```

All regions

This example defines carrier lifetimes and the refractive index for all semiconductor regions.

```
MATERIAL TAUP0=2.E-6 TAUN0=2.E-6 REAL. INDEX=3.7 \
IMAG. INDEX=1.0E-2
```

Named Material

This shows the definition of bandgap for all InGaAs regions in the structure:

```
MATERIAL MATERIAL=InGaAs EG300=2.8
```

All materials are divided into three classes: semiconductors, insulators and conductors. See [Appendix B “Material Systems”](#) for more information about the parameters required for each material class.

Note: You can use the MODEL PRINT command to echo back default material parameters or MATERIAL parameter settings to the run-time output.
